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ANGULAR UNCONFORMITY MARKS TRIASSIC-JURASSIC BOUNDARY IN SNAKE RIVER AREA OF NORTHEASTERN OREGON

By

R. F. Morrison*

Introduction

A well-defined angular unconformity between Triassic and Jurassic strata is exposed along the valley of the Snake River about 40 miles south of Lewiston, Idaho. The Triassic rocks below the hiatus consist of poorly sorted clastics derived from a volcanic terrain; contemporaneous extrusive rocks; and well bedded, fossiliferous, impure limestones. Above the unconformity is more than 1000 feet of black shale which encompasses conformable beds of chert-pebble conglomerate and lenses of protoquartzite. Thick sills of quartz diorite have been intruded into the black shales.

During the summer of 1961, an examination was made of the pre-Tertiary rocks which crop out along the canyon of the Snake River between Cache Creek and the mouth of the Imnaha River. The accompanying sketch map shows the approximate extent of pre-Tertiary rocks surrounding the area of interest. Further extent of pre-Tertiary rocks in northeastern Oregon has been shown by N. S. Wagner in the July 1958 issue of The Ore.-Bin.

Previous Work

The existence of significant exposures of pre-Tertiary rocks underlying the Columbia River basalts along the canyons of the middle Snake and lower Salmon Rivers has been known for more than 60 years. Russell (1901) described the rocks in this area as follows:

> The stratified rocks are much disturbed, but in general the beds strike about northeast and southwest, or directly across the Snake River. The dip of the beds shows great variation, indicating the beds were disturbed, largely perhaps on account of the intrusion of porphyry beneath and among them, forming dikes....Certain layers are exceedingly coarse, being in reality conglomerates, containing water-worn pebbles six or more inches in diameter....The variety of rocks at the locality referred to (Cottonwood Creek) and the abundance of good exposures make it a favorable place for a detailed study of the geology and the topography of the old land over which the Columbia River lava was outpoured.

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The age of the strata at these particular exposures was not determined by Russell. Lindgren (1900, Plate IX), however, tentatively dated similar slates, schists and old effusive rocks along the canyon of the Salmon River south of Grangeville as Carboniferous in age. Sediments of definite Triassic age were also reported by Lindgren (1904) from the mining districts in the Seven Devils.

More recent examination of some of the pre-Tertiary rocks exposed along the Snake and Salmon River canyons has been made by W. R. Wagner (1945). In discussing exposures in the vicinity of Riggins, Idaho, he points out (page 3):

> The oldest group of rocks includes a thick succession of flows and pyroclastics which have been named the Seven Devils volcanics and which in adjacent areas carries a Permian fauna of Phosphoria age. The Pittsburg formation rests unconformably on the older rocks and is composed largely of sandstone and conglomerate which has been derived by erosion of the Seven Devils volcanics....Younger than the sandstones and conglomerates is another group of rocks called the Lucile series, which consists of crystalline limestone, phyllites, and slates which are believed to be of Triassic age.

The Seven Devils volcanics of the lower Salmon River country have been tentatively correlated by Cook (1954) with the Clover Creek greenstone, named by Gilluly (1937) for exposures in the vicinity of Baker, Oregon. Cook, however, emphasizes the preponderance of sediments in the Seven Devils volcanics and suggests that this formation is "largely the result of submarine volcanism and sedimentation near the source of volcanic debris." He suggests that these sediments range in age from Permian to Triassic.

Jurassic sediments associated with the Permo-Triassic "greenstones" of northeastern Oregon and adjacent areas of Idaho have been reported by Livingston (1932, p. 34) who found "excellent fossil ammonites...of upper Jurassic age" in shales at Dennet Creek near Mineral, Idaho.

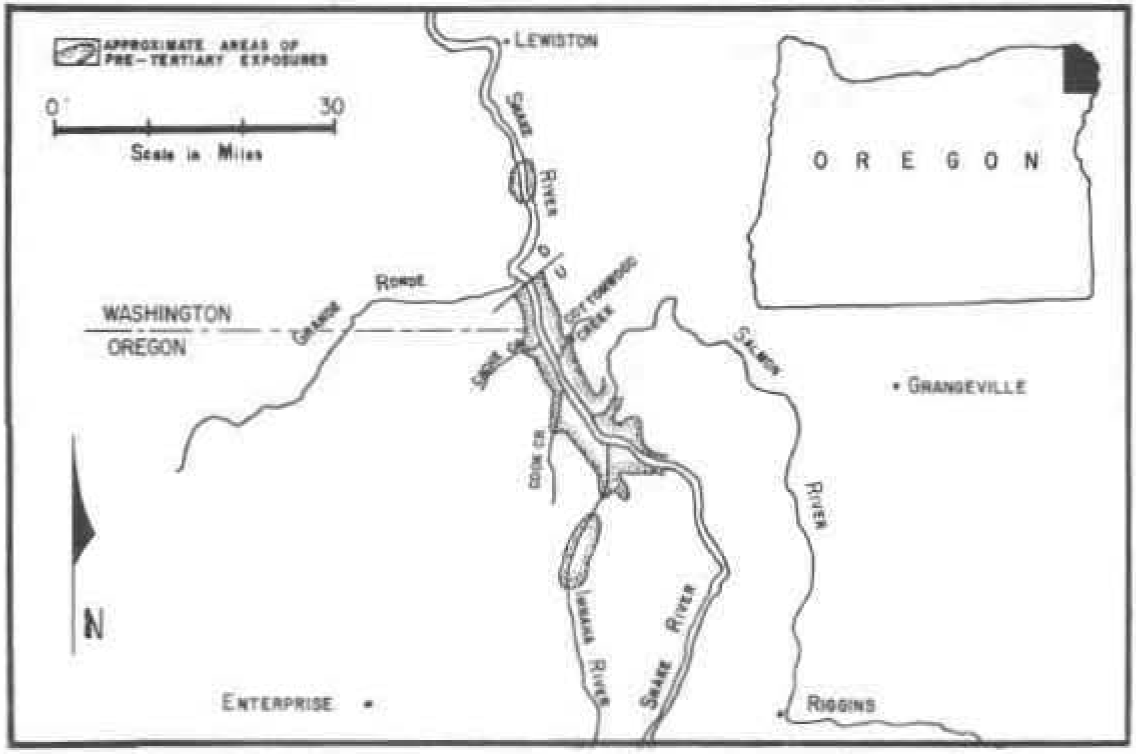
Stratigraphy of Layered Pre-Tertiary Rocks

It has proved unfeasible to construct a single detailed stratigraphic column which is accurate for all locations even within the limited area of pre-Tertiary exposures between Cache Creek and the mouth of the Imnaha River. Precise correlation of various units is complicated by:

a) Intricate structure which includes numerous local faults (100 to 500 feet displacement) and an undetermined number of larger faults.
b) Rapid facies changes. Although specific examples of facies changes have not been demonstrated, extensive continuity of extremely coarse, angular rudites (which are often among the most distinctive units) seems improbable.
c) The abundance of dikes and sills of varying composition and age. These occur very typically between individual layered units and tend to mask the original nature of many of the sedimentary contacts.

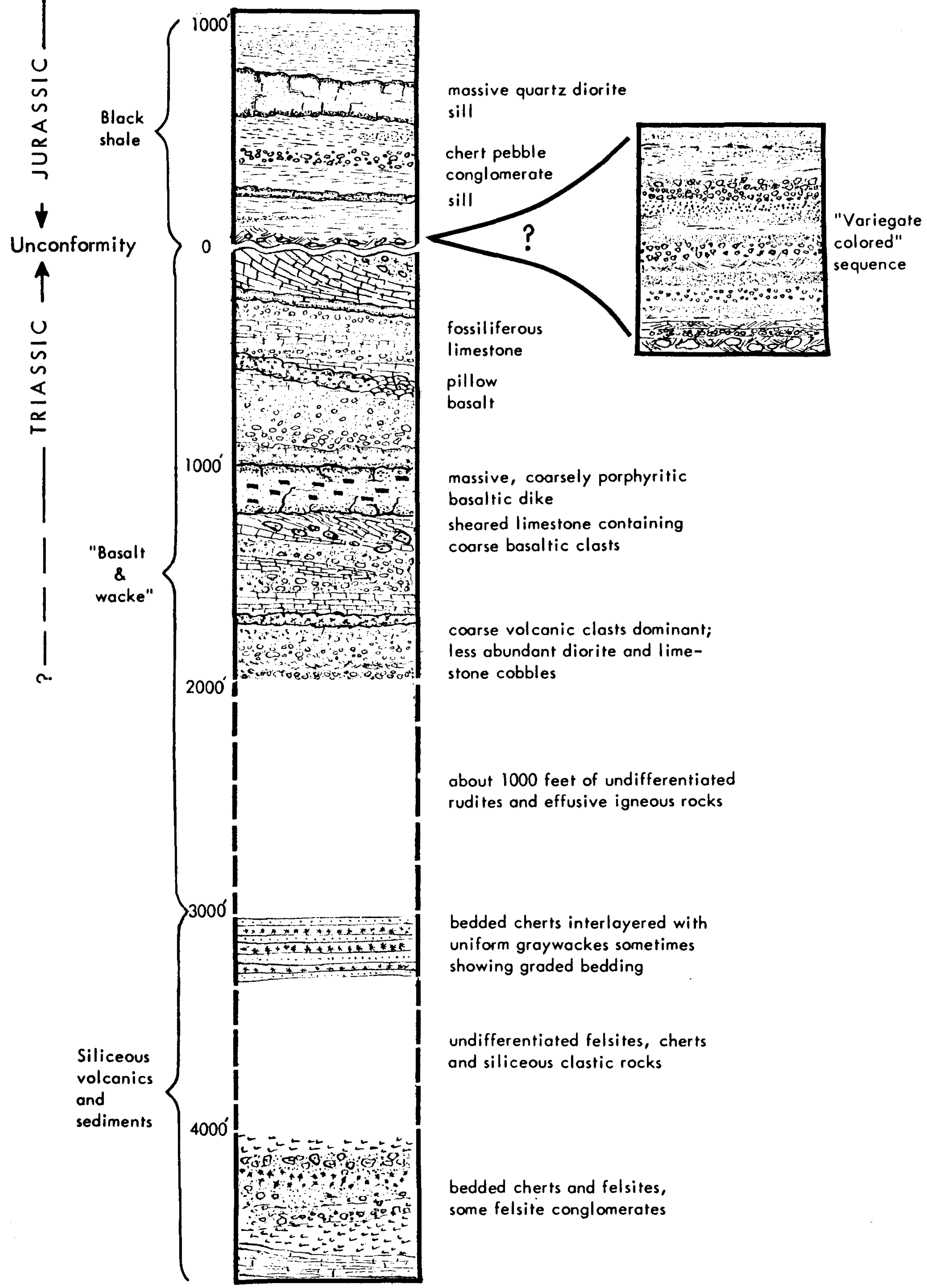
Despite the uncertainties introduced by these factors, a representative stratigraphic column has been constructed. The upper part of this column has been drawn from sections measured with a plane table and alidade. These were correlated with the aid of certain limestone units which are sufficiently continuous to serve as good marker beds. The lower part of the column was for the most part based on estimates. In this portion of the section, the best marker horizon is a well-bedded chert which extends across the area of pre-Tertiary outcrop.

Regardless of variations in detail which would undoubtedly occur in stratigraphic columns measured at different locations, it does seem valid to divide the pre-Tertiary rocks in this area



Sketch map showing approximate extent of pre-Tertiary rocks in specific area of interest.

Angular unconformity between Triassic limestones and conglomerates and overlying Jurassic black shales. Location of photograph is 1 mile north of the mouth of Cottonwood Creek, looking west across the Snake River, which is in the foreground.



Representative Stratigraphic Column

into four major units. Among the oldest rocks, cherts, felsites, and possibly fine-grained silicified tuffs are predominant. Overlying these with unknown contact relations is a series of more mafic rocks, among which are abundant quartz-poor rudites, composed mainly of angular fragments of vesicular basalt or andesite in a chlorite-rich matrix. This is designated the "basalt and wacke"* unit. These are, in turn, separated by an angular unconformity from the youngest sediments which consist of black shales containing interbedded protoquartzites and chert-pebble conglomerates. The fourth major unit is of uncertain stratigraphic position. It consists of clearly defined conglomerate beds, variegate-colored shales, and current cross-bedded sands which are in part lithologically similar to the basal conglomerate of the black shale unit. Field mapping, however, has not established positive correlation.

Each of these four major rock units represents the product of a distinctive sedimentary, or volcano-sedimentary environment. The oldest rocks were formed during a phase of relatively siliceous volcanism. Sediments of this period show dominantly deep water characteristics. Many have fine-grained texture; bedding tends to be thin and clearly defined; graded bedding occasionally occurs, but there is a lack of cross-bedding; and there is almost a total absence of carbonates.

In contrast, the deposition of the overlying "basalt and wacke" unit occurred in a somewhat shallower marine environment with associated volcanism of basaltic or andesitic composition. Beds of clastic rock in this unit are massive, containing angular fragments as much as several feet in diameter. A moderately shallow water environment is also suggested by the presence of impure bedded limestone, particularly in the upper part of the unit. Interbedded pillow basalts, as well as the abundance of volcanic clasts in the water-laid material, is conclusive evidence of contemporaneous volcanism.

The black shale unit, at the top of the stratigraphic column, has been deposited in an environment which lacks significant volcanic contribution. Thin uniform bedding, which characterizes the fine-grained portions, suggests a relatively stable depositional basin. Even the subordinate coarser fractions of this unit are mature sediments composed of rounded and well-sorted chert pebbles or relatively clean quartz-sand lenses.

A near-shore, rapidly changing, shallow water environment is postulated to explain the well-bedded unit of uncertain stratigraphic position. Rounded conglomerates alternating with variegate-colored shales and quartz sands which display clear current cross-bedding indicate deposition under variable conditions, characterized at times by moderately strong currents. The conglomerate, in addition to containing quartz grains, clasts of dense volcanics, and pumiceous particles, also includes coarse fragments of diorite and an occasional limestone cobble.

The truncation of almost horizontal Triassic limestones and conglomerates by gently dipping Jurassic shales is illustrated in the accompanying photograph. In addition to the evidence provided by the angular discordance, the unconformity can be traced in the field by a distinctive basal conglomerate. The unit immediately above the break consists of a clean, current cross-bedded sand which contains rounded limestone boulders as much as 4 feet in diameter. These boulders are lithologically identical to the impure limestone beds that occur in the upper third of the "basalt and wacke" sequence which crops out below the unconformity.

A time hiatus in the depositional history, which coincides with the lithological and structural features that define this unconformity, can be demonstrated on the basis of fossil evidence. Specimens of limestone from the upper part of the "basalt and wacke" sequence beneath the unconformity have been dated as Middle to Upper Triassic by Dr. David Bostwick of Oregon State University.

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* The term "wacke" is used as part of a field name to designate a poorly sorted rudite deposited in an aqueous environment. Clastic fragments include a mixture of rock types, mainly volcanic in origin.

The Triassic fauna includes Thamnastraea sp. and Halobia sp., as well as a variety of other colonial corals, brachiopods, and pelecypods.

The black shale above the unconformity has yielded a well-preserved ammonite specimen, belonging to the subfamily Cardioceratinae, which is probably a species of the genus Amoeboceras. According to Dr. S. Muller, who identified the specimen, this genus is restricted to the Oxfordian stage of the Upper Jurassic.

Plutonic Rocks

The coarse-grained plutons, which are exposed within the area of pre-Tertiary layered rocks, are summarized only briefly because they have not been examined in detail. The largest continuous exposures are along the lower canyon of the Imnaha River and immediately adjacent portions of the Snake River canyon. Although the intervening area is masked by flows of Columbia River basalt, this Imnaha Valley intrusive body can be extended 5 miles to the northwest, to the upper end of Cook Creek where exposures of similar intrusive rock occur. A few miles north of Cache Creek, beyond the boundaries of the immediate area of interest, are additional outcrops of plutonic rocks.

Variable composition characterizes the Imnaha Valley intrusive body. Unaltered gabbro, containing less than 3 percent quartz, is included near the center of the mass along the Imnaha River, but closer to its margins there is found abundant quartz diorite in which the plagioclase has been strongly saussuritized. Within a wide marginal zone along the border of the intrusive are pods of sheared granite and numerous felsitic, as well as basaltic, dikes.

A well-developed primary fabric, defined by parallel orientation of plagioclase and pyroxene crystals and by uniformly aligned xenoliths and schlieren, occurs at many localities within the igneous body. Wherever observed, these features have a consistent attitude of about N. 65° W., dipping approximately 60° N. It is the orientation of this internal fabric which suggests that the Imnaha Valley intrusive body may be elongated in a generally northwesterly direction, justifying its hypothetical extension to include the exposures of diorite near the upper end of Cook Creek.

The age of the Imnaha Valley intrusive body has not been established. Sills of quartz diorite more than 200 feet thick are included within the black shales, indicating that there has been post-Oxfordian igneous activity in this area, but the relation which these sills may bear to the Imnaha Valley intrusive body is not known.

Conclusions

1) Four major units which are believed to correspond to distinctive sedimentary or volcano-sedimentary environments can be differentiated on the basis of lithologic variations. Detailed mapping, however, which is necessary to define accurate relations between some of these units, is complicated by rapid facies changes, intricate structures, and abundance of dikes and sills that tend to mask original contacts.

2) Careful examination of the stratigraphy of layered rocks within a limited area along the canyon of the Snake River does not reveal an excessive thickness of either sediments or volcanics. The area of interest extends about 10 miles at roughly right angles to the northeasterly trend of much of the bedding; the total stratigraphic thickness, including both measured and estimated portions of the column, is probably in the neighborhood of about 6,000 feet.

3) An angular unconformity, which can be bracketed by fossil evidence, indicates that a period of tilting, erosion, and uplift occurred in northeastern Oregon some time between the Upper Triassic and the Upper Jurassic.

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CARBON 14 TEST DATES LOON LAKE

Ewart M. Baldwin, professor of geology at the University of Oregon, reports that a sample of wood taken from a standing tree in Loon Lake, Douglas County, and sent to Dr. Willard Libby for age determination by the carbon 14 method, was found to be 1,460 years, plus or minus 80. The sample was sent to Dr. Libby by Miss Harriet Ward, resident on the shore of the lake, who recognized that a dating of the outer part of the tree would give the date the lake was formed. According to Dr. Baldwin, Loon Lake was caused by a landslide in which a large mass of Tyee sandstone slipped down from the western slope of the valley of Lake Creek, forming a dam behind which the water was quickly impounded.

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CORNUCOPIA GOLD MINE SOLD

A Spokane investor (Nov. 20) bought for $11,100 the famed Cornucopia Mine, which once yielded an estimated $15 million in gold.

Craig Stolle purchased the long-abandoned Eastern Oregon mine property for his father, Carl M. Stolle, a partner in Stolle Investment Co., at a bankruptcy sale.

The assets include 1,000 acres of land, half a dozen old mine buildings, and part of the abandoned townsite of Cornucopia.

The mine was opened about 1884. At one time, 350 persons worked and lived at Cornucopia. Stolle said his father hopes the price of gold will increase so that some day it may be profitable to reopen the mine, which has not been worked for 20 years.

Possibility of developing the area as a resort also was mentioned. (The Oregonian, Nov.22, 1961)

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THE HOUSE THAT MINERALS MADE

by

R. S. Mason*

The day has nearly arrived when you can build a house entirely from minerals. Such a house would be fireproof, termiteproof, soundproof, and weatherproof. Depending on the owner's choice of materials the structure would be almost paintproof too. Just what will this house use to provide all these wonderful benefits?

Starting with the basement, walls and floor will be of concrete blocks or of reinforced concrete poured into metal forms which have neither cracks nor knotholes. Some houses may even use steel cables for horizontal and vertical post-tensioning to give greater strength and to prevent cracks. Sand and gravel under the floors and a petroleum-base emulsion on the outside of the walls will insure that the basement is dry. The ceiling joists over the basement and the first floor sub-floor will be single pre-cast lightweight concrete units which will be delivered to the job ready for laying, with openings for heating ducts, plumbing, and electrical conduits already provided. The steps up from the basement will arrive in one piece and will be pre-cast lightweight concrete with metal railing already installed.

Exterior walls now offer a wide variety of choice. Traditional brick in many colors, textures, and sizes; building stone either sawn, split, or rubble in numerous colors and textures; concrete block in unit sizes, half high,ashlar, or random, with plain or textured surfaces and in many colors; and monolithic concrete with any one of many surface textures, are some of the possibilities for the solid wall areas of the modern house. Recent perfection of tilt-up wall construction methods has lowered the cost of laying rubble building stone to the point where it is competitive with many other materials. Exterior walls of prefabricated modular-sized panels of coated steel or aluminum sheets fastened to metal frames are available in a variety of colors.

Steel or aluminum joists and rafters will be assembled at the plant and the trusses delivered to the job ready for installation. The ceiling joists will have metal clips for attaching plasterboard. Roof construction will be a far cry from the methods used since man moved out of a cave. Depending on conditions and the owner's preference, the roof could be made of clay or concrete tile or slate attached to metal strips, or large, pre-fabricated roof sections of aluminum or ceramic-coated steel shingles could be used. Built-up roofs, using colorful crushed rock poured over asphalt-coated lightweight concrete slabs are also possible. Chimneys of traditional brick or concrete blocks will be competing with multi-wall steel and aluminum stacks which can be erected rapidly.

Inside the house-made-with-minerals, walls of gypsum board or plaster laid over perforated gypsum lath would find increasing competition from wall panels of ceramic-coated metal, plastic, or foamed concretes. Interior walls of translucent glass or plastic would be lighter than those made of the traditional materials and could be installed or removed readily. Exposed aggregate concrete block with smoothly sanded surfaces is a new development which should find its way into the interior walls of many homes.

Floor coverings of vinyl acetate linoleum and similar plastics in work areas would contrast with all-mineral rugs of tough glass fibers or plastic yarns. Furniture of steel, aluminum, fiberglass, and plastic would be lightweight and durable. Windows, set in steel or aluminum sash, would have draperies or curtains made of glass fibers, plastics, or metallic yarn.

Utilities would use quantities of pipe made of cast iron, steel, and copper; sheets of galvanized steel for air ducts, vents, and louvers; and pounds of miscellaneous metal fasteners such as nuts and bolts, screws, clips, and rivets. Insulation from heat and cold would be provided by rock wool, glass fibers, or asbestos. Light may come from regular fixtures or entire wall or ceiling panels may be phosphor-coated glass or plastic which glow at the flip of a switch.

For the home owner whose house has a steel or aluminum frame with metal exterior and interior wall panels there are certain bonus features. Changes in floor plan are simple operations of unbolting clips and moving unit sections to a new place. Should the owner of a metal house wish to move he can, if he desires, take it with him, after unbolting the sections and dismantling them with the aid of a small lift truck.

Heated electrically or by fossil fuels such as coal, oil, and gas, the mineral-made house also will pick up extra thermal energy from the sun through double-glass windows which trap the radiant heat inside. If, for old time's sake, the owner wants a cheerful fire on his hearth, he will have to bring in a log or two, but that is the only time wood will be used.

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*Mining engineer, Oregon State Department of Geology and Mineral Industries.

Materials for the House Made of Minerals

Use	Material	Mineral or Rock
Basement walls and floor	Reinforced concrete, concrete block	Sand, gravel, limestone, clay, gypsum, hematite, chromite
Walls	Brick and tile	Clay, sand, limestone
	concrete block	limestone, clay, gypsum, sand, gravel
	natural stone	volcanic tuff, sandstone
	steel, aluminum	hematite, bauxite, feldspar
Sash and doors	Aluminum or steel	Bauxite, hematite
Windows	Glass	Soda ash, quartz
Ceiling joists (basement)	Pre-cast concrete	Expanded shale, cinders or pumice limestone, clay, gypsum
Rafters and joists	Metal trusses of steel or aluminum	Bauxite, hematite
Roof	Tile	Clay
	slate	slate
	aluminum shingles	bauxite
	ceramic coated steel	hematite, feldspar
	aggregate	dolomite, quartz, opalite, chert,
	concrete tile	limestone, sand and gravel, clay
Chimneys	Brick and tile	Clay, limestone, sand
	steel or aluminum pipe	hematite or bauxite
	concrete block	limestone, sand and gravel, clay
Draperies, rugs	Plastic, metallic or glass fibers	Halite, coal, limestone, hematite chromite, soda ash, quartz
Linoleum	Vinyl asbestos	Coal, limestone, asbestos
Plumbing	Iron, steel, copper pipe	Hematite, chalcopyrite
	lead caulking	galena
	fixtures	chalcopyrite, hematite, zinc, nepheline syenite, chromite, garnierite
Heating	Oil or gas furnace	Hematite, chalcopyrite, sheelite
	electric panels	chalcopyrite, garnierite, chromite
	radiant floors	chalcopyrite
Electrical	Wiring, switches, fixtures	Chalcopyrite, platinum, galena, sphalerite, hematite, chromite, cinnabar, sheelite
Cupboards, cabinets	Stainless steel	Hematite, chromite, garnierite
	aluminum	bauxite

LIST OF THESES ON OREGON GEOLOGY GROWS

The following master's theses were completed in 1959, 1960, and 1961 by graduate students of geology at the University of Oregon. The list supplements "Bibliography of Theses on Oregon Geology," by H. G. Schlicker, published by the department as Miscellaneous Paper No. 7, 1959. Theses marked with an asterisk may be consulted at the department library in Portland.

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PORTLAND EXTENSION CENTER SCHEDULES NEW CLASS

Portland Extension Center has scheduled Course ChE 405, Reading and Conference: Assaying (OSU) for the winter term at Portland State College. It is an evening class and is planned to cover the fundamentals of assaying and geochemical prospecting, which should be of interest to chemistry students, geologists, prospectors, mining engineers and others. The enrollment is limited to 25. Registration only made be made by application to the instructor after December 11. The instructor may be reached at BE5-0043 daily after 5:30 p.m.

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